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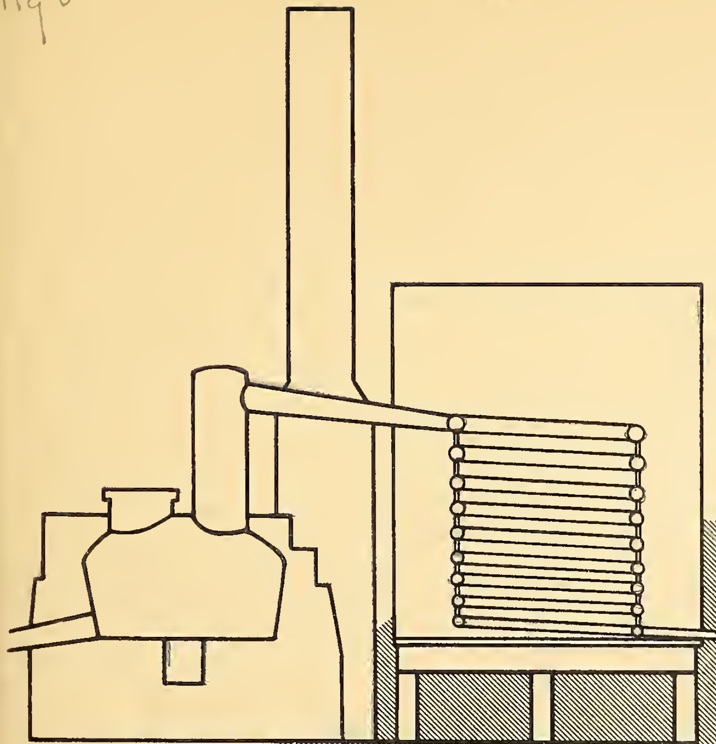

JET CONDENSER SET-UP
FOR TURPENTINE STILL

BY E. L. PATTON AND R. A. FEAGAN, JR.

BUREAU OF AGRICULTURAL
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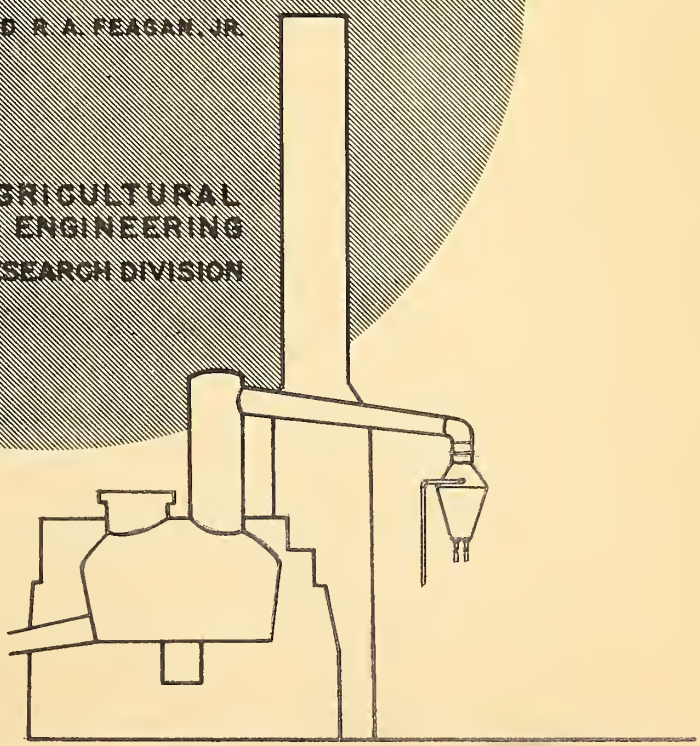

UNITED STATES DEPARTMENT OF AGRICULTURE

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Bureau of Agricultural Chemistry and Engineering
Naval Stores Research Division
C. F. Speh, Chief

JET CONDENSER SET-UP FOR TURPENTINE STILL

By

E. L. Patton, Chemical Engineer, and
R. A. Feagan, Jr., Junior Chemical Engineer

Report on Equipment Development
Naval Stores Station, Olustee, Florida
G. P. Shingler, Senior Chemist in Charge

1941

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By E. L. Patton and R. A. Feagan, Jr.,
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INTRODUCTION

For many years the naval stores industry has used a tub and worm to condense the vapors in the distillation of turpentine. In this type of condenser the wall of the copper worm is between the hot turpentine and low wine vapors and the cooling water, and the heat from these vapors is conducted through the copper wall to the water in the tub, causing the vapors to be cooled and condensed.

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PRINCIPLE OF THE JET CONDENSER

In the jet-type condenser, the vapors are also cooled by water but the water is sprayed directly into the vapors and carries the heat away without the interfering resistance of the copper wall. The basic principle of the jet condenser has been used in other industries for some time, but its adaptation to turpentine distillation is new and is of distinct advantage. Thus, by using a jet condenser, the relatively large tub and worm can be replaced by a simple water spray in a can that is also equipped with baffles. The vapors from the turpentine still enter the can and are met by a direct spray of water. Thorough mixing of the vapors and water is assured by the baffles installed in the can, and the cool water cools and condenses the vapors. The condensed vapors and water pass out of the can to gravity separators that separate the turpentine from the water in the same manner as used for years to separate turpentine from low wine. The only difference in the separation is that there is more water to be separated from the turpentine because the cooling water has been sprayed directly into the vapors. For that reason, two separators are used and the condensate is divided between them. One large separator would be satisfactory but the cost of construction would be greater than for the two small ones, assuming that standard 55-gallon drums can be used in the construction of the latter.

ADVANTAGES OF JET CONDENSER

It would be easy to spray enough water to cool the turpentine and the low wine almost to the temperature of the cooling water. However, this would represent a waste of cooling water since nothing is to be gained by cooling the hot low wine. Therefore, in the proper operation of the jet condenser only enough water is sprayed into the condenser to condense the turpentine and cool it to about 160° or 170° Fahrenheit. The hot turpentine is then separated from the hot low wine; the latter is discharged to the sewer; and the hot turpentine is passed through a cooler which reduces the temperature to about 90° F. or lower, depending on the temperature of the cooling water. The water which passes through the turpentine cooler is piped to the jet condenser where it is sprayed into the incoming vapors.

By cooling only the turpentine and leaving the low wine hot, this type of condenser uses less water than is used by the conventional tub and worm, based on a definite, continuous rate of distillation. Its capacity is dependent only on the amount of water that can be supplied to it and mixed with the hot vapors. For new installations, there is an additional saving because the jet condenser, an extra separator, and a cooler cost less than a tub and worm condenser.

The quality of the turpentine is improved by the jet condenser, since the extra washing removes much of the acid which is normally distilled over with the turpentine.

DESCRIPTION OF EQUIPMENT

Although many possible types and arrangements of equipment can be constructed to carry out the basic idea of the jet condenser, one design will be described in detail for the benefit of those who wish to use this type of condenser on their turpentine stills.

Jet Condenser Proper. The jet condenser set-up is shown in Figure 4, and a detailed drawing of the jet condenser proper is shown in Figure 1. The vapors from the turpentine still enter the top of the condenser from an arm leading from the vapor dome of the still. No dimension has been given for the flange at the top of the condenser because of the diameter of the arm connection of turpentine stills varies, depending on the make. The top connection of the condenser should be made to conform to the size of the arm connection on the still to be used. A slight taper is permissible in the arm connecting the still and the jet condenser. The spray used in this condenser is easily obtained by making hack-saw cuts across a 1-1/2-inch by 5-inch capped pipe nipple. The cuts which extend to about half of the circumference are staggered around the pipe and the water sprays from them at all points around the pipe. If these cuts are properly spaced, as indicated in the drawing, excellent

distribution of the cooling water will result. The baffles installed in the lower part of the condenser are cut from perforated sheet metal and spot welded to the inside of the condenser shell. A 4- or 5-inch hole is cut in each baffle to prevent any possibility of back pressure being built as a result of clogging of the small perforations. These baffles assist in thoroughly mixing the hot vapors and the cooling water. The shape of the shell of the condenser is not important; it could be built "top-shaped," as shown in Figure 1, or in the form of a cylinder. The joints may be welded, brazed, riveted and soldered, or joined in some other manner, depending on the metal used in the construction. Two standard 2-inch pipe couplings are welded in the bottom for connecting the pipe that carries the condensed turpentine to the gravity separators.

Gravity Separators: Automatic gravity separators have been used for many years to separate the low wine and turpentine. In the case of the jet condenser, all of the cooling water is mixed with the turpentine and low wine. Thus more separator capacity is needed. This problem could be solved by using one large separator but it will be cheaper to use two smaller units in parallel, since standard 55-gallon drums can be used in the construction. The method of building the separators from such drums is shown in Figure 2. If the drums do not have removable heads, the top must be cut out of each drum in order that baffles may be installed. The two large horizontal baffles for each separator are cut from perforated sheet metal and are spot welded to the sides of the drums. These baffles increase the efficiency of the separator by preventing "swirling." A small baffle is cut from solid sheet metal and welded across each drum just below the top and in front of the condensate inlet (2-inch opening at top of drum in Figure 2). This baffle deflects the incoming condensate and keeps the water from getting into the turpentine outlet which is the standard 1-inch opening near the top of the drum.

After the baffles are installed, each separator must be fitted with a vapor-tight lid. If a friction-lid drum has been used, the friction lid may be put back on the drum. However, if it is necessary to cut the top out, another cover may be made vapor-tight by the use of gaskets and self-tapping screws or by some other means. The lid must be made vapor tight to prevent evaporation loss, because the separation of the water and turpentine is carried out at a fairly high temperature (160° to 170° F.).

At the present time, (Feb. 1941), experiments are underway at the Naval Stores Station to determine the life of a standard steel drum converted to separator use. There is a possibility that steel will prove satisfactory, because the low wine, which contains some acid, is greatly diluted by the cooling water. Pending completion of the experiments, however, it can only be stated that stainless steel or other metal resistant to the action of turpentine and low wine will prove satisfactory.

Turpentine Cooler: The hot turpentine from the separators is passed through a cooler which reduces the temperature to about 90° F. or lower, depending on the temperature of the cooling water. The construction of this cooler is shown in Figure 3. It consists of a coil, through which the turpentine flows, and a jacket

through which the cooling water flows around the coil. The same water which flows through the cooler is piped to the jet condenser where it is sprayed into the incoming vapors. Other types of coolers can be used satisfactorily. For example, an efficient cooler can be built in the form of concentric pipes, the turpentine flowing in the inner pipe with cooling water in the outer pipe.

The three circular baffles installed between the coils of the cooler (see Figure 3) make it more efficient by forcing the cooling water to circulate around the cooling coil. The cool turpentine from the cooler is piped directly to a standard salt dehydrator.

Complete Jet Condenser Set-up. In Figure 4 the piping connections are shown for the jet condenser and auxiliary equipment. The equipment should be arranged so as to make the piping as short and direct as possible and the valves should be readily accessible to the stiller from the lower floor.

The separators must be raised as shown in the drawing, in order to allow room for a cooler above the dehydrator. This provision also furnishes a pressure head which makes the turpentine flow through the cooler. If the distances allowed are less than those shown in Figure 4 it will be necessary to use larger tubing in the turpentine cooler.

In the case of existing stills, it will probably be of advantage to install the separators on the charging deck of the still, and close together. The condenser must be installed above the separators and, if necessary, connected to the still with a "goose-neck" arm.

OPERATION

For correct operation, the turpentine still must be equipped with a recording thermometer. When the still is fired, the valve controlling the cooling water is opened slightly to allow a small stream of water to enter the jet condenser.

When the still thermometer shows a temperature of about 190° F. (just before the still starts to run) condensate samples are drawn off at intervals from the 1/2-inch sample line (see Figure 4.) Before the still starts, these samples will be cool and will consist entirely of water. As soon as the still starts running, samples drawn from the sampler pipe will contain turpentine and will be warmer. At this time the valve admitting water to the condenser is opened until the condensate samples have a temperature of about 160° to 170° F. (too hot to be comfortable to the touch). The water valve should be regulated during the run to maintain this temperature, which will require only two or three adjustments during the run.

The progress of the distillation is followed with the still thermometer, water being supplied at definite temperatures as recommended in one of the publications of this Station.* The still is run until no turpentine shows on the sample drawn from the condensate line, and the still temperature has reached the turning-out point recommended by the Station.* It should be noted that the "spirit line" of the condensate sample taken from the jet condenser is not the "spirit line" referred to in "Directions for Running a Turpentine Still,"* because of the addition of the cooling water to the vapors. At no time during the charge is the "spirit line" below "8" in a ten-ounce graduate (nursing bottle). This condition is normal because of the water added to the low wine.

WATER REQUIRED

A continuous supply of cooling water is required at a pressure of at least 12 to 15 pounds per square inch at the condenser. The amount of cooling water required is, of course, dependent on the rate of distillation and on the temperature of the cooling water. When the cooling water has a temperature of 70° F. a still running 10 barrels of crude gum in two hours will require a total of about 2,000 gallons of cooling water per charge or about 17 gallons per minute. The measurements made at the Naval Stores Station have shown that a 35-barrel worm and tub uses about 30 gallons of water per minute for the same size of charge run in the same time, after the water originally in the tub has become "hot".

The jet condenser will handle condensate much faster than this if more cooling water is supplied. For example, in tests at the Naval Stores Station as much as 1,300 pounds of turpentine was distilled (from cleaned gum) in an hour and the condenser handled this load with cooling water supplied at about 28 gallons per minute.

PRECAUTION

The jet condenser is designed to handle only the vapors of turpentine and low wine given off during normal distillation. The still should not be overcharged so that entrainment (or boil-over) occurs. If, however, there is danger of a still being operated in such a way as to boil over a standard entrainment trap should be installed between the still and the condenser. To prevent damaging the still by back pressure, in case the condenser becomes clogged, it is well to install on the vapor dome of the still a standard 2-inch pressure relief valve set to operate at about 3 pounds.

This equipment was designed to handle rates of turpentine condensation up to 200 gallons (1,440 pounds) of turpentine per hour. This is more turpentine than is distilled over in the average turpentine still, but it is not recommended that the equipment be made smaller than specified. If more turpentine is to be condensed, the engineers of the Naval Stores Station will be glad to discuss the problem with still operators and revise the sizes to meet existing needs.

* Directions for Running Crude Gum on a Turpentine Fire Still, by G. P. Shingler, ACE-54. (Mimeographed.)

NOT SUITABLE FOR ALL STILLS

It must be emphasized that the jet condenser is not practical for all turpentine stills, although it is of great advantage under proper conditions.

It should not be used on small stills that handle only one or two charges per day, because the amount of cooling water used by the jet condenser would be greater than that used by the tub and worm when there is enough time between charges for the tub full of water to cool.

Those interested in the jet condenser can see it in operation by visiting the Naval Stores Station at Olustee, Florida.

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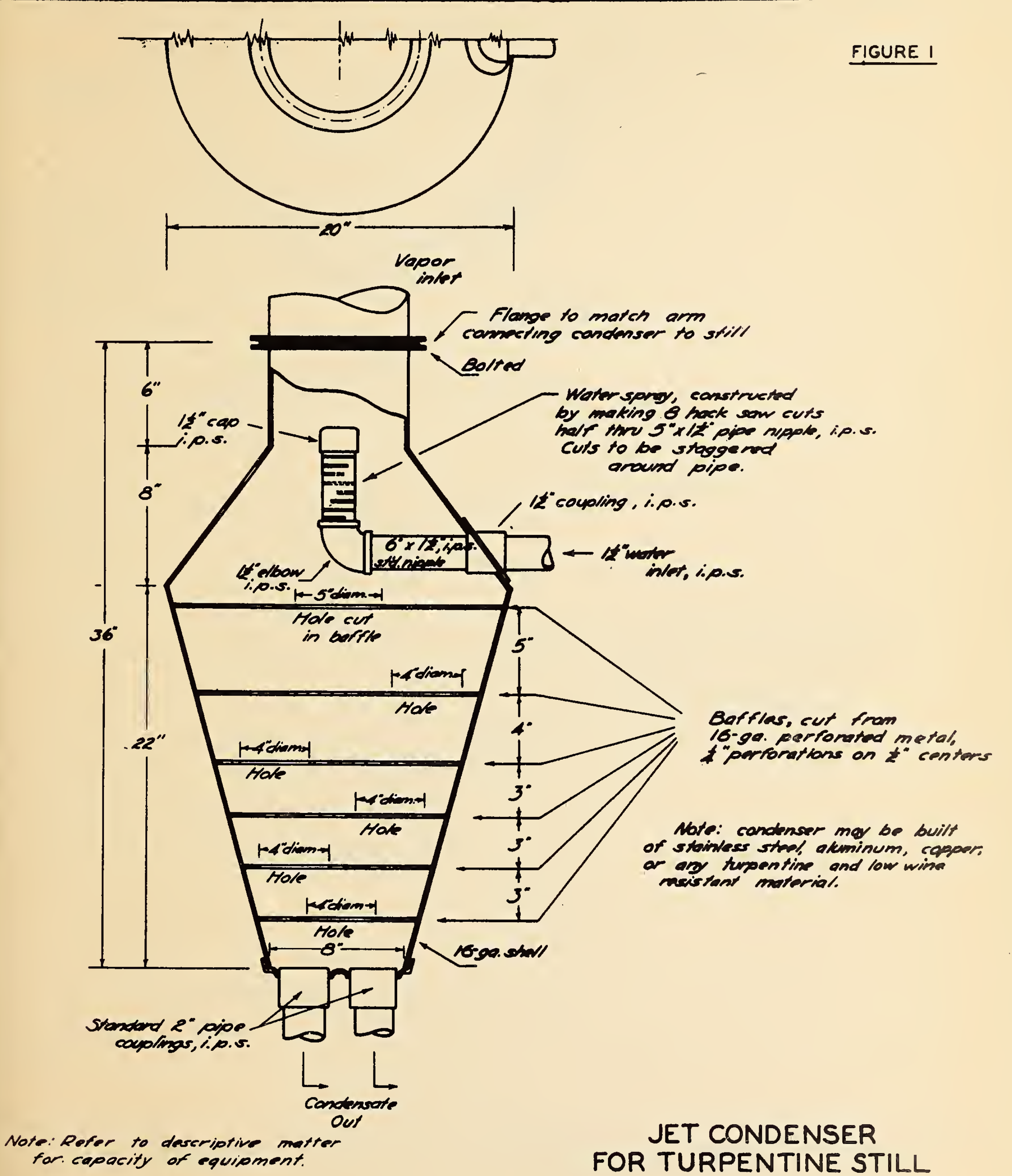
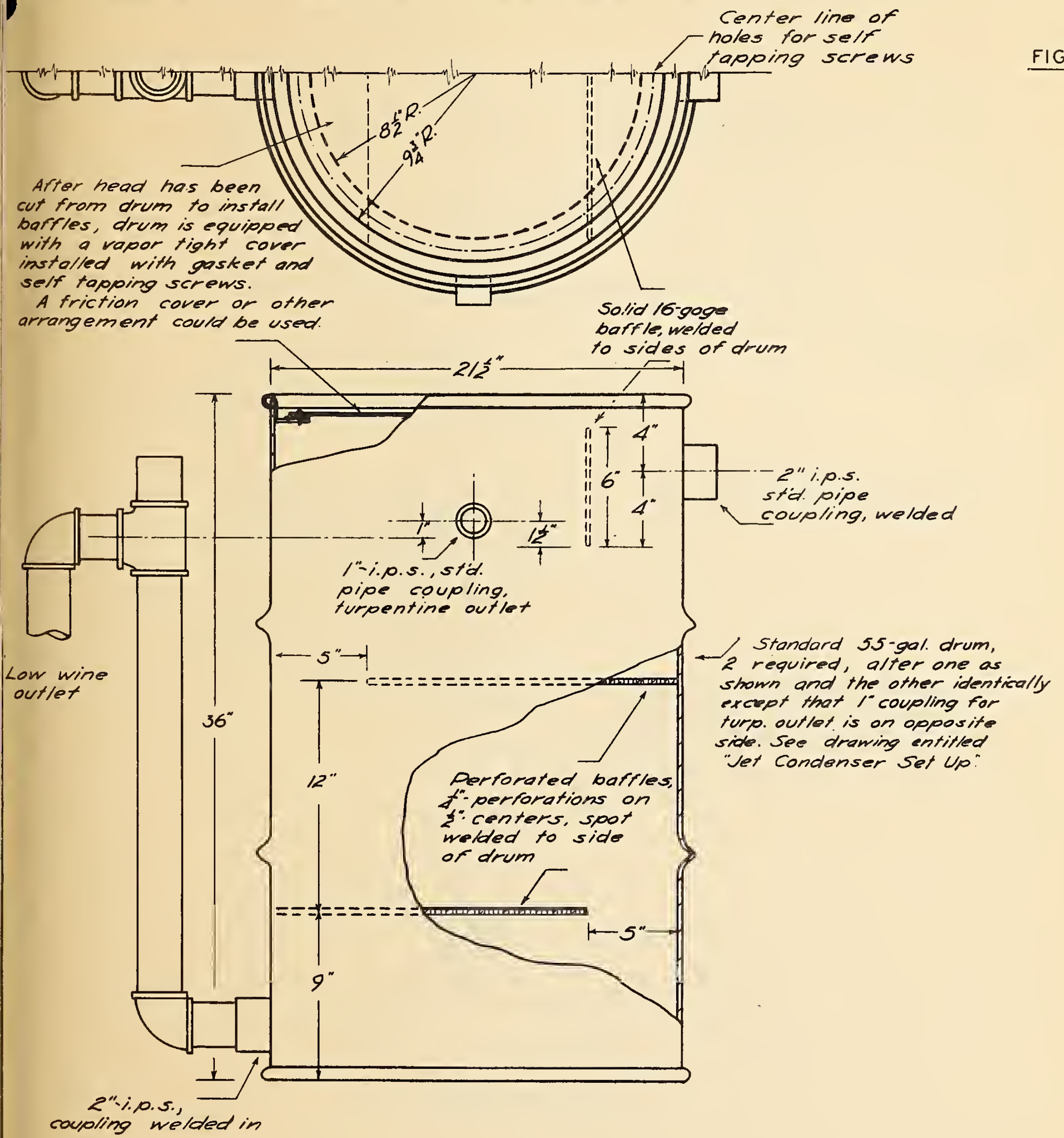


JET CONDENSER
FOR TURPENTINE STILL

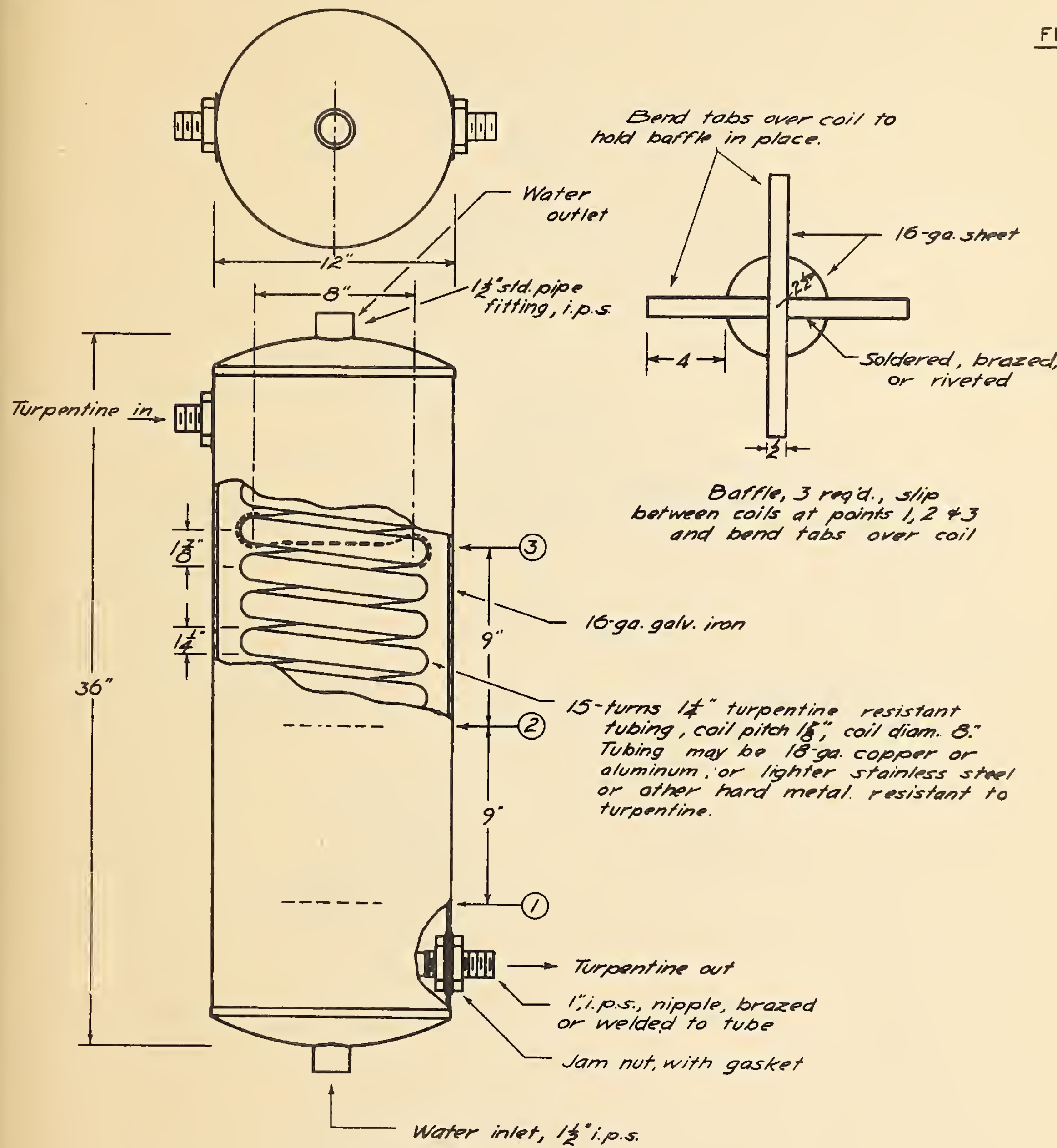
FIGURE 2



Note: Refer to descriptive matter for capacity of equipment.

TURPENTINE-WATER SEPARATOR
FOR TURPENTINE STILL

FIGURE 3



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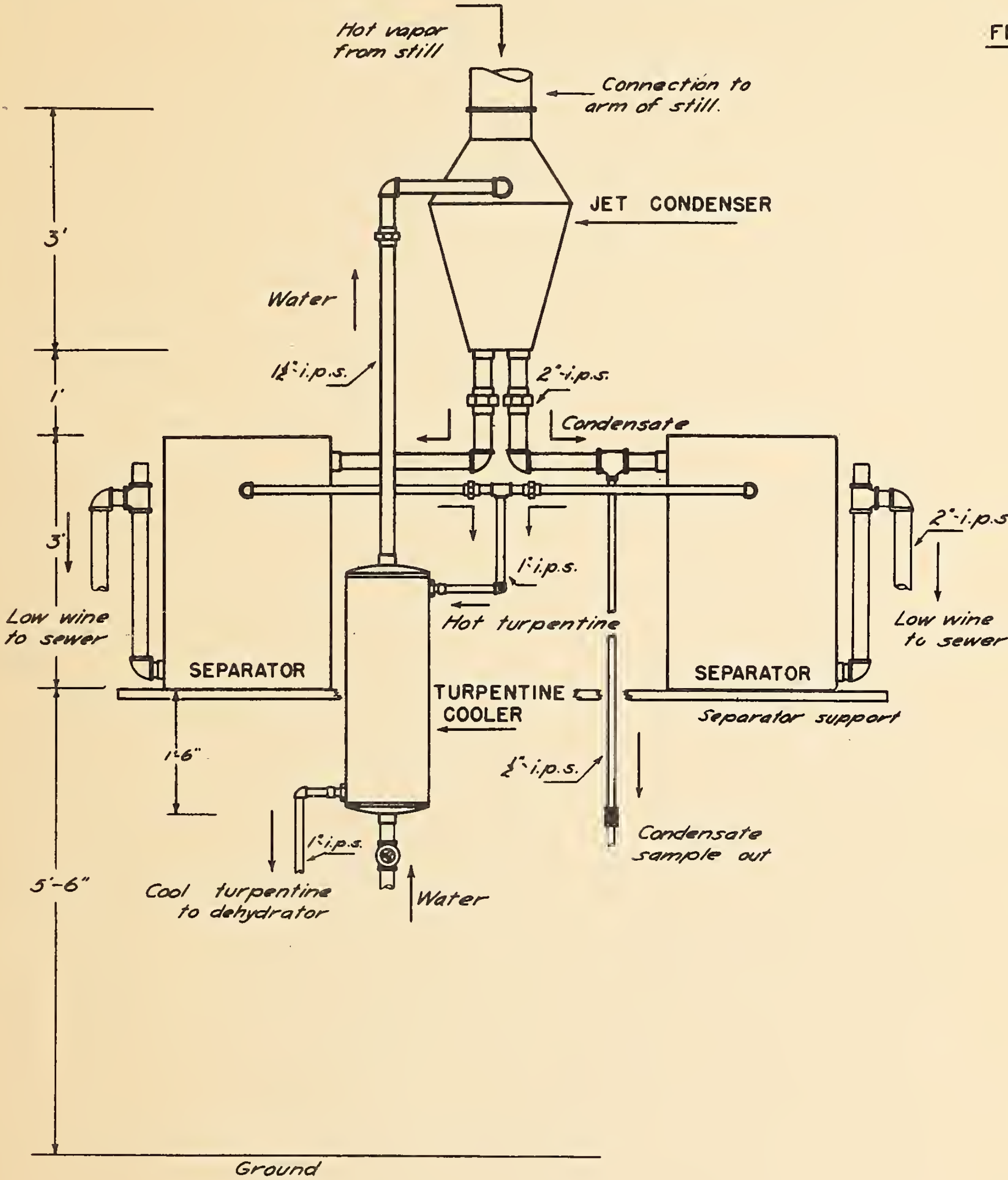
TURPENTINE COOLER FOR JET CONDENSER

FIGURE 4



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